Article 34 Amendment

Dated: June 7, 2005

AMENDMENT (Translation)

(Amendment under Art. 11)

To: Commissioner, Patent Office

1. Identification of the International Application

PCT/JP2004/000742

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4. Date June 7, 2005

5. Object of Amendment

Specification, Claim and Drawing

6. Contents of Amendment

(1) "the powder has an average value of particle diameters not more than 3 micrometers, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers" in page 4, lines 21 to 22 of the Japanese text is amended to "the powder has an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, and the electrode material of the electrode is uniform and capable of forming a thick film with thickness not less than 100 micrometers".

(2) "the powder has a scaly shape" in page 5, line 1 of the Japanese text is amended to "an aspherical shape".

(3) "electrode is capable" in page 5, lines 6 to 7 of the Japanese text is amended to "the electrode has uniform hardness and is capable".

(4) "the powder has an average value of particle diameters equal to or smaller than 1 micrometer" in page 5, line 17 of the Japanese text is amended to "the powder has an average

value of particle diameters not less than 10 nanometers and equal to or smaller than 1 micrometer".

(5) "have predetermined hardness" in page 5, line 21 of the Japanese text is amended to "have predetermined uniform hardness".

(6) "powder with an average value of particle diameters equal to or smaller than 3 micrometers" in page 6, line 2 of the Japanese text is amended to "powder with an average value of particle diameters not less than 10 nanometers and equal to or smaller than 3 micrometers".

(7) "an electrode made of the electrode material" in page 6, line 2 of the Japanese text is amended to "uniform electrode made of the electrode material".

(8) "using an electrode of the electrode material" in page 6, line 9 of the Japanese text is amended to "using an electrode with uniform hardness made of the electrode material".

(9) "an average value of particle diameters equal to or smaller than 1 micrometer" in page 6, line 11 of the Japanese text is amended to "an average value of particle diameters

not less than 10 nanometers and equal to or smaller than 1 micrometer".

(10) "an electrode made of the electrode material capable of forming a film with thickness equal to or larger than 100 micrometers having an average value of particle diameters equal to or smaller than 3 micrometers" in page 6, lines 22 to 23 of the Japanese text is amended to "a uniform electrode made of the electrode material capable of forming a film with thickness equal to or larger than 100 micrometers having an average value of particle diameters not less than 10 nanometers and equal to or smaller than 3 micrometers".

(11) "an electrode of the electrode material" in page 7, line 6 of the Japanese text is amended to "an electrode with uniform hardness made of the electrode material".

(13) "with an average value of particle diameters equal to or smaller than 1 micrometer" in page 7, line 8 of the Japanese text is amended to "with an average value of particle diameters not less than 10 nanometers and equal to or smaller than 1 micrometer".

(14) "the powder has an average value of particle diameters

not more than 3 micrometers, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers" in claim 1, lines 6 to 8 of the Japanese text is amended to "the powder has an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, and the electrode material of the electrode is uniform and capable of forming a thick film with thickness not less than 100 micrometers".

(15) "powder having a particle diameter not more than 3 micrometers is mixed in a proportion not less than 10% in the powder, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers" in claim 2, lines 6 to 8 of the Japanese text is amended to "powder having a particle diameter not less than 10 nanometers and not more than 3 micrometers is mixed in a proportion not less than 10% in the powder, and the electrode material of the electrode has uniform composition and hardness and is capable of forming a thick film with thickness not less than 100 micrometers".

(16) "the powder has a scaly shape" in claim 5, line 6 of the Japanese text is amended to "in the electrode according to claim 1, the powder has an aspherical shape".

(17) Claim 6 is amended to "The electrode for discharge surface treatment according to claim 5, wherein a shape of the powder is a scaly shape or a polygonal shape."

(18) Delete claim 7.

(19) "the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers" in claim 8, line 6 of the Japanese text is amended to "the electrode material of the electrode has uniform hardness and is capable of forming a thick film with thickness not less than 100 micrometers".

(20) "the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers" in claim 9, line 6 of the Japanese text is amended to "the electrode material of the electrode has uniform hardness and is capable of forming a thick film with thickness not less than 100 micrometers".

(21) The entire claim 16 is amended to "The electrode for discharge surface treatment according to claim 1, wherein the powder has an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer.".

(22) "the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, and the powder contains a predetermined quantity or more of powder with an average value of particle diameters not more than 1 micrometer as the electrode material" in claim 17, lines 6 to 8 of the Japanese text is amended to "in the electrode according to claim 1, the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, and the powder contains 80% or more of powder with an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer as the electrode material".

(23) "have predetermined hardness" in claim 19, line 3 of the Japanese text is amended to "have predetermined uniform hardness".

(24) "the film is formed using an electrode obtained by compression-molding powder with an average value of particle diameters not more than 3 micrometers, using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers" in claim 26, lines 6 to 8 of the Japanese text is amended to "the film is formed using a uniform electrode

obtained by compression-molding powder with an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers"

(25) "the film is formed using an electrode obtained by compression-molding powder mixed with powder having a particle diameter not more than 3 micrometers mixed in a proportion not less than 10% in the powder, and using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers" in claim 27, lines 6 to 8 of the Japanese text is amended to "the film is formed using an electrode having uniform composition and hardness and obtained by compression-molding powder mixed with powder having a particle diameter not less than 10 nanometers and not more than 3 micrometers mixed in a proportion not less than 10% in the powder, and using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers".

(26) "the film is formed using an electrode" in claim 28, line 7 of the Japanese text is amended to "the film is formed using a uniform electrode".

(27) "the film is formed using an electrode" in claim 29, line 7 of the Japanese text is amended to "the film is formed using a uniform electrode".

(28) "according to any one of claims 28 to 35" in claim 36, line 3 of the Japanese text is amended to "according to any one of claims 28 to 33, and 35".

(29) "according to any one of claims 28 to 36" in claim 37, line 3 of the Japanese text is amended to "according to any one of claims 28 to 33 and 35 to 36".

(30) The entire claim 38 is amended to "The discharge surface treatment method according to claim 26, wherein the powder has an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer".

(31) The entire claim 39 is amended to "The discharge surface treatment method according to claim 27, wherein the electrode contains 80% or more of powder having an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer".

(32) "the powder has an average value of particle diameters

not more than 3 micrometers, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers" in claim 43, lines 7 to 9 of the Japanese text is amended to "the powder has an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, and the electrode material of the electrode is uniform and capable of forming a thick film with thickness not less than 100 micrometers".

(33) "powder having a particle diameter not more than 3 micrometers is mixed in a proportion not less than 10% in the powder, and the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers" in claim 44, lines 7 to 9 of the Japanese text is amended to "powder having a particle diameter not less than 10 nanometers and not more than 3 micrometers is mixed in a proportion not less than 10% in the powder, and the electrode material of the electrode is uniform and capable of forming a thick film with thickness not less than 100 micrometers".

(34) "the electrode is manufactured from an electrode material" in claim 45, line 9 of the Japanese text is amended to "a uniform electrode is manufactured from an electrode

material".

(35) "the electrode is manufactured from an electrode material" in claim 46, lines 9 to 10 of the Japanese text is amended to "a uniform electrode is manufactured from an electrode material".

(36) The entire claim 55 is amended to "The discharge surface treatment apparatus according to claim 43, wherein powder with an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer is used."

(37) The entire claim 56 is amended to "The discharge surface treatment apparatus according to claim 44, wherein the electrode contains 80% or more of powder having an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer."

7. Attached Documents

(1) Pages 4 to 7/1 of the Japanese text

(2) Claim 43 to 54

Moreover, since powder manufactured by the atomizing method is manufactured by evaporating a material and condensing the material, obtained powder has a spherical shape because of an influence of a surface tension. There is also a problem in that, when an electrode is formed of such spherical powder, since powder particles are in point contact with one another, bonding among the particles is weakened to make the powder fragile.

The present invention has been devised in view of the problems and it is an object of the present invention to obtain an electrode for discharge surface treatment that has uniform hardness, has uniform thickness at the time of the discharge surface treatment, and is capable of forming a thick film with thickness not less than about 100 micrometers.

It is another object of the present invention to obtain an electrode for discharge surface treatment that has uniform hardness and is capable of forming a uniform and sufficiently dense thick film at the time of the discharge surface treatment. It is still another object of the present invention to obtain an electrode for discharge surface treatment that is capable of forming a thick film having abrasion resistance and lubricity under a high-temperature environment.

It is still another object of the present invention

to obtain a discharge surface treatment apparatus that uses the electrode for discharge surface treatment and a method for the discharge surface treatment apparatus.

DISCLOSURE OF INVENTION

To achieve the objects, according to an aspect of the present invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the powder has an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, and the electrode material of the electrode is uniform and capable of forming a thick film with thickness not less than 100 micrometers.

According to another aspect of the present invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of

metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the powder has an aspherical shape.

According to still another aspect of the present invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the electrode material of the electrode has uniform hardness and is capable of forming a thick film with thickness not less than 100 micrometers, the powder is obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder, and

the large-diameter powder is a mixture in 5 to 60 volume percent.

According to still another aspect of the present invention, in an electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, and the powder has an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer.

Moreover, to achieve the objects, according to still another aspect of the present invention, a manufacturing method for an electrode for discharge surface treatment, includes a first step of grinding powder of metal, a metallic compound, or ceramics into aspheric powder having a predetermined particle diameter and scaly shape with a grinder; and a second step of compress-molding the powder ground into a predetermined shape to have predetermined

uniform hardness.

Moreover, to achieve the objects, according to still another aspect of the present invention, a discharge surface treatment method of causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the film is formed using a uniform electrode obtained by compression-molding powder with an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, in a discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode

material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the film is formed using a uniform electrode obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder and compression-molding the powders, the large-diameter powder being in 5 to 60 volume percent, and using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, in discharge surface treatment method of causing electric discharge between an electrode made of electrode material that is capable of forming a thick film with thickness not less than 100 micrometers and consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

Moreover, to achieve the objects, according to still

another aspect of the present invention, in a discharge surface treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic compound and a work piece on which a film is formed, the electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, the powder has an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, and the electrode material of the electrode is uniform and capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, a discharge surface treatment apparatus includes an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound; a work piece on which a film is formed; and a power supply apparatus electrically connected to the electrode and the work piece, the discharge surface

treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece. A uniform electrode is manufactured from an electrode material that is obtained by mixing a small-diameter powder having a distribution of small particles and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder, the large-diameter powder being in 5 to 60 volume percent, and the electrode material being capable of forming a thick film with thickness not less than 100 micrometers.

According to still another aspect of the present invention, an electrode is made of an electrode material that is capable of forming a thick film with thickness not less than 100 micrometers consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer; a work piece on which a film is formed; and a power supply apparatus electrically connected to the electrode and the work piece, the discharge surface treatment apparatus generating pulse-like

electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a schematic of a structure of a turbine blade of a gas turbine engine for an aircraft;

Fig. 2 is a schematic of discharge surface treatment in a discharge surface treatment apparatus;

Fig. 3A is a chart of a voltage waveform of a voltage applied between an electrode for discharge surface treatment at the time of electric discharge and a work;

Fig. 3B is a chart of a current waveform of a current flowing to the discharge surface treatment apparatus at the time of electric discharge;

Fig. 4 is a flowchart of an example of a manufacturing process for an electrode for discharge surface treatment;

Fig. 5 is a schematic sectional view of a state of a molding device at the time when powder is molded;

Fig. 6 is a schematic of a hardness fluctuation test;

Fig. 7 is a graph of a granularity distribution of stellite powder after grinding 50 hours;

Fig. 8 is an SEM (Scanning Electron Microscope) photograph of a state of the inside of an electrode manufactured from scaly stellite powder with an average particle diameter of 1.8 micrometers;

Fig. 9 is an SEM photograph of a state of the inside of an electrode manufactured as a comparative example from spherical stellite powder with an average particle diameter of 6 micrometers;

Fig. 10 is a photograph of a deposition state of powder processed under this condition;

Fig. 11 is a schematic of a grinding principle of a bead mill apparatus;

Fig. 12 is a graph of a granularity distribution of stellite powder after grinding six hours;

Fig. 13 is a schematic of a constitution of an electrode material in an eighth embodiment of the present invention;

Fig. 14A is an SEM photograph of a state of a film at the time when the discharge surface treatment is performed with small discharge energy using an electrode containing large-diameter powder at a ratio of 10%;

Fig. 14B is an SEM photograph of a state of a film at the time when the discharge surface treatment is performed with small discharge energy using an electrode containing large-diameter powder at a ratio of 50%;

Fig. 14C is an SEM photograph of a state of a film at the time when the discharge surface treatment is performed with large discharge energy using an electrode containing large-diameter powder at a ratio of 50%;

CLAIMS

1. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the powder has an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, and the electrode material of the electrode is uniform and capable of forming a thick film with thickness not less than 100 micrometers.

2. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric

discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

powder having a particle diameter not less than 10 nanometers and not more than 3 micrometers is mixed in a proportion not less than 10% in the powder, and the electrode material of the electrode has uniform composition and hardness and is capable of forming a thick film with thickness not less than 100 micrometers.

3. The electrode for discharge surface treatment according to claim 2, wherein the powder has a particle diameter varied in powder of an identical component.

4. The electrode for discharge surface treatment according to any one of claims 1 to 3, wherein the powder contains any one of stellite, Ti-coated CBN, Tic+Ti, Cr_2C_3+Cr, Cr_2C_3+stellite, Al_2O_3+Ni, ZrO_2+Ni, and stellite+Co.

5. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound,

or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

in the electrode according to claim 1, the powder has an aspherical shape.

6. (Currently Amended) The electrode for discharge surface treatment according to claim 5, wherein a shape of the powder is a scaly shape or a polygonal shape.

7. (Deleteded)

8. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the

discharge energy on a surface of the work piece, wherein the electrode material of the electrode has uniform hardness and is capable of forming a thick film with thickness not less than 100 micrometers, the powder is obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder, and the large-diameter powder is a mixture in 5 to 60 volume percent.

9. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein the electrode material of the electrode has uniform hardness and is capable of forming a thick film with thickness not less than 100 micrometers, the powder is obtained by mixing a small-diameter powder having a

distribution of small particle diameters not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers, and the large-diameter powder is in 5 to 20 volume percent.

10. The electrode for discharge surface treatment according to claim 8 or 9, wherein the small-diameter powder is metal powder refined by grinding.

11. The electrode for discharge surface treatment according to any one of claims 8 to 10, wherein the large-diameter powder has a substantially spherical shape.

12. The electrode for discharge surface treatment according to any one of claims 8 to 11, wherein the powders to be mixed have an identical component.

13. The electrode for discharge surface treatment according to any one of claims 8 to 12, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

14.

15. The electrode for discharge surface treatment according to any one of claims 8 to 13, wherein the

large-diameter powder is in 5 to 20 volume percent.

16. (Currently Amended) The electrode for discharge surface treatment according to claim 1, wherein the powder has an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer.

17. (Currently Amended) An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

in the electrode according to claim 1, the electrode material of the electrode is capable of forming a thick film with thickness not less than 100 micrometers, and the powder contains 80% or more of powder with an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer as the electrode material.

18. The electrode for discharge surface treatment according to claim 16 or 17, wherein the powder contains any one of Co powder, Co alloy powder, Mo powder, Cr powder, W powder, Zr powder, Ta powder, Ti powder, V powder, and Nb powder.

19. (Currently Amended) A manufacturing method for an electrode for discharge surface treatment, comprising:

a first step of grinding powder of metal, a metallic compound, or ceramics into aspheric powder having a predetermined particle diameter and scaly shape with a grinder; and

a second step of compress-molding the powder ground into a predetermined shape to have predetermined uniform hardness.

20. The manufacturing method for an electrode for discharge surface treatment according to claim 19, wherein the grinder is a mill apparatus.

21. The manufacturing method for an electrode for discharge surface treatment according to claim 20, wherein the mill apparatus is any one of a ball mill apparatus, a bead mill apparatus, a vibrating mill apparatus, and a jet mill apparatus.

22. The manufacturing method for an electrode for discharge surface treatment according to claim 20 or 21, wherein the mill apparatus includes a container and balls made of a same material as material of the powder to be ground.

23. The manufacturing method for an electrode for discharge surface treatment according to claim 20 or 21, wherein the mill apparatus includes a container and balls with surfaces thereof subjected to build up welding, plating, or thermal spraying using a same material as a material of the powder to be ground.

24. The manufacturing method for an electrode for discharge surface treatment according to claim 20, wherein a material of the mill apparatus is ZrO_2.

25. The manufacturing method for an electrode for discharge surface treatment according to any one of claims 19 to 24, wherein, in the first step, the predetermined particle diameter is not more than 3 micrometers.

26. (Currently Amended) A discharge surface treatment method of causing, with a green compact obtained

by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the film is formed using a uniform electrode obtained by compression-molding powder with an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

27. (Currently Amended) A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the film is formed using an electrode having uniform composition and hardness and obtained by compression-molding powder mixed with powder having a particle diameter not less than 10 nanometers and not more than 3 micrometers mixed in a proportion not less than 10% in the powder, and using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

28. (Currently Amended) A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the film is formed using a uniform electrode obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder and compression-molding the powders, the large-diameter powder being in 5 to 60 volume percent, and using the electrode made of the electrode

material that is capable of forming a thick film with thickness not less than 100 micrometers.

29. (Currently Amended) A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the film is formed using a uniform electrode obtained by mixing a small-diameter powder having a distribution of small particle diameters not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers and compression-molding the powders, the large-diameter powder being in 5 to 60 volume percent, and using the electrode made of the electrode material that is capable of forming a thick film with thickness not less than 100 micrometers.

30. The discharge surface treatment method according to claims 28 or 29, wherein the small-diameter powder is powder

refined by grinding.

31. The discharge surface treatment method according to any one of claims 28 to 30, wherein the large-diameter powder has a substantially spherical shape.

32. The discharge surface treatment method according to any one of claims 28 to 31, wherein the small-diameter particle and the large-diameter particle have an identical component.

33. The discharge surface treatment method according to any one of claims 28 to 32, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

34.

35. The discharge surface treatment method according to any one of claims 28 to 33, wherein the large-diameter powder is in 5 to 20 volume percent.

36. (Currently Amended) The discharge surface treatment method according to any one of claims 28 to 33, and 35, wherein

the electrode and the work piece are arranged in a

machining fluid or a predetermined gas atmosphere, and

electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

37. (Currently Amended) The discharge surface treatment method according to any one of claims 28 to 33 and 35 to 36, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

38. (Currently Amended) The discharge surface treatment method according to claim 26, wherein the powder has an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer.

39. (Currently Amended) The discharge surface treatment method according to claim 27, wherein the electrode contains 80% or more of powder having an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer.

40. The discharge surface treatment method according to any one of claims 38 to 39, wherein

the electrode and the work piece are arranged in a

machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

41. The discharge surface treatment method according to any one of claims 38 to 39, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

42. The discharge surface treatment method according to any one of claims 38 to 41, wherein the powder is powder of metal, a metal compound, or ceramics.

43. (Currently Amended) A discharge surface treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic compound and a work piece on which a film is formed, the electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance

generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein the powder has an average value of particle diameters not less than 10 nanometers and not more than 3 micrometers, and the electrode material of the electrode is uniform and capable of forming a thick film with thickness not less than 100 micrometers.

44. (Currently Amended) A discharge surface treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic compound and a work piece on which a film is formed, the electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein powder having a particle diameter not less than 10 nanometers and not more than 3 micrometers is mixed in a proportion not less than 10% in the powder, and the electrode material of the electrode is uniform and capable of forming

a thick film with thickness not less than 100 micrometers.

45. (Currently Amended) A discharge surface treatment apparatus comprising:

an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound;

a work piece on which a film is formed; and

a power supply apparatus electrically connected to the electrode and the work piece,

the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

a uniform electrode is manufactured from an electrode material that is obtained by mixing a small-diameter powder having a distribution of small particles and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder, the large-diameter powder being in 5 to 60 volume percent, and the electrode material being capable of forming a thick film with thickness not less than 100 micrometers.

46. (Currently Amended) A discharge surface treatment apparatus comprising:

an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound;

a work piece on which a film is formed; and

a power supply apparatus electrically connected to the electrode and the work piece,

the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

a uniform electrode is manufactured from an electrode material that is obtained by mixing a small-diameter powder having a distribution of small particles not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers, the large-diameter powder being in 5 to 60 volume percent, and the electrode material being capable of forming a thick film with thickness not less than 100 micrometers.

47. The discharge surface treatment apparatus according to claims 45 or 46, wherein the small-diameter powder is

powder refined by grinding.

48. The discharge surface treatment apparatus according to any one of claims 45 to 47, wherein the large-diameter powder has a substantially spherical shape.

49. The discharge surface treatment apparatus according to any one of claims 45 to 48, wherein the small-diameter particle and the large-diameter particle have an identical component.

50. The discharge surface treatment apparatus according to any one of claims 45 to 49, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

51. The discharge surface treatment apparatus according to any one of claims 45 to 40, wherein the large-diameter powder is in 5 to 60 volume percent.

52. The discharge surface treatment apparatus according to any one of claims 45 to 50, wherein the large-diameter powder is in 5 to 20 volume percent.

53. The discharge surface treatment apparatus according to any one of claims 45 to 52, wherein

the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and

electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

54. The discharge surface treatment apparatus according to any one of claims 45 to 53, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

55. (Currently Amended) The discharge surface treatment apparatus according to claim 43, wherein powder with an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer is used.

56. (Currently Amended) The discharge surface treatment apparatus according to claim 44, wherein the electrode contains 80% or more of powder having an average value of particle diameters not less than 10 nanometers and not more than 1 micrometer.

57. The discharge surface treatment apparatus according to any one of claims 55 to 56, wherein

the electrode and the work piece are arranged in a

machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

58. The discharge surface treatment apparatus according to any one of claims 55 to 56, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

59. The discharge surface treatment method according to any one of claims 55 to 56, wherein the powder is powder of metal, a metal compound, or ceramics.

手 続 補 正 書

（法第１１条の規定による補正）

特許庁長官 殿

（特許庁審査官 大畑 通隆 殿）

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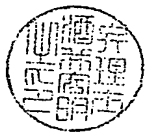

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４．通知の日付　０７．６．２００５

５．補正の対象

明細書及び請求の範囲

６．補正の内容

（１）明細書第４頁第２１～２２行目の「前記粉末は、３μｍ以下の平均粒径を有し、前記電極は、厚さ１００μｍ以上の」を、「前記粉末は、１０ｎｍ以上３μｍ以下の粒径の平均値を有し、前記電極は均質であり、厚さ１００μｍ以上の」に補正する。

（２）明細書第５頁第１行目の「鱗片状の形状」を、「非球形の形状」に補正する。

（３）明細書第５頁第６～７行目の「前記電極は、厚さ１００μｍ以上の」を、「前記電極は、均一な硬さであり、厚さ１００μｍ以上の」に補正する。

（４）明細書第５頁第１７行目の「前記粉末は、１μｍ以下の粒径の」を、「前記粉末は、１０ｎｍ以上１μｍ以下の粒径の」に補正する。

（５）明細書第５頁第２１行目の「所定の硬さを有する」を、「所定の均一な硬さを有する」に補正する。

（６）明細書第６頁第１行目の「３μｍ以下の粉末」を、「１０ｎｍ以上３μｍ以下の粉末」に補正する。

（７）明細書第６頁第２行目の「電極材料から成る電極」を、「電極材料から成る均質な電極」に補正する。